CHAPTER 6

PERSONAL PROTECTIVE EQUIPMENT

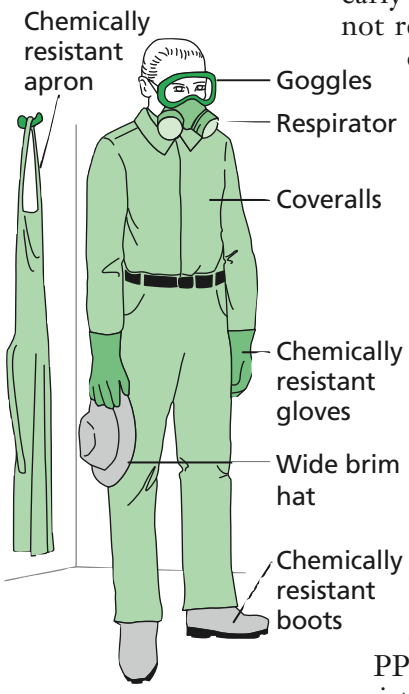
LEARNING OBJECTIVES

After studying this chapter, you should:

- Know how to identify the minimum personal protective equipment (PPE) required during pesticide application to be in compliance with regulations.
- Know how to select and wear safety equipment (e.g., gloves, boots, eye protection) according to label directions and regulations considering the length of exposure, exposure situation, and chemical to which one is exposed.
- Know how to select and properly wear PPE for protection of skin, eyes, and respiratory tract.
- Understand the importance of selecting, fit testing, and wearing respiratory devices (e.g., respirators, self-contained breathing apparatus) according to label directions and regulations.
- Know how to inspect for signs of wear and tear, damage, or other failures to PPE that may lead to exposure.
- Know when and how to dispose of personal protective equipment.
- Know how to clean, maintain, and store personal protective equipment according to manufacturers' recommendations.

Pesticides can pose hazards to humans. Remember, hazard depends on the product's toxicity and length of exposure. The severity of a pesticide poisoning depends on the pesticide's chemical makeup and formulation, its path into the body, the amount that enters the body, and the length of exposure. Wearing PPE can greatly reduce the potential for dermal, inhalation, eye, and oral exposure, and thereby significantly reduce the chances of a pesticide poisoning. "PPE" refers to clothing and devices worn to protect the human body from contact with pesticides or pesticide residues. PPE includes such items as coveralls or protective suits, footwear, gloves, aprons, respirators, eyewear, and headgear. PPE reduces exposure but does not necessarily eliminate it.

All pesticide handlers — applicators, mixer/loaders, flaggers, etc. — and early-entry agricultural workers are legally required to follow all PPE instructions that appear on the product label. A pesticide label lists



Wearing appropriate types of personal protective equipment (PPE) can greatly reduce the risk of pesticide exposure.

the *minimum* PPE that a person must wear while performing handling or early-entry activities. If the label does not require PPE or requires only one or two pieces of PPE, a cautious handler may decide to wear additional PPE for increased safety. Sometimes a label has different PPE requirements for pesticide handlers and early-entry workers. In addition, many states have specific labor laws and rules that regulate access to, training with, and use of PPE.

PPE offers various levels of protection, depending on the type of resistant material used. Some items of PPE simply act as filters by keeping dry or spray material off the skin. Others offer better protection against water-based products. Some offer protection from chemicals (solvent and/or active ingredient) that make up a concentrated pesticide product. PPE must be comfortable to ensure that people wear it and wear it properly. This chapter describes the types of PPE that are typically available for protection against pesticide exposure.

CHEMICAL-RESISTANT CLOTHING

The term **"chemical resistant"** means that no measurable movement of the pesticide through the material occurs during the period of use. Some PPE is **water resistant** only. "Water resistant" refers to PPE that keeps a small amount of fine spray particles or small liquid splashes from penetrating the clothing and reaching the skin. **Waterproof** (liquidproof) material keeps water-soluble materials out, but it may not necessarily keep out oil solvent-based products. Waterproof materials include items made of plastic or rubber. Some materials are actually chemically resistant. The chemical resistance of a material is an indication of how strongly it resists chemical penetration by pesticide products during use. Read the PPE packaging carefully to determine whether the protective item is chemical resistant, liquidproof, or water resistant.

Clothes made of cotton, leather, or canvas are not chemically resistant, even to dry formulations.

When making a decision about which protective equipment to use, follow these general guidelines. Cotton, leather, canvas, and other absorbent materials are not chemically resistant even to dry formulations. Powders and dusts sometimes move through cotton and other woven materials as quickly as liquid formulations. Also, they may remain in the fibers even after several launderings. Do not use a hat that has a cloth or leather sweatband, and do not use cloth or cloth-lined gloves, footwear, or aprons. Cloth is difficult or impossible to clean after it becomes contaminated with pesticide, and it is usually too expensive to be disposed of and replaced after one use.

Gloves, boots, aprons, suits, and hoods come in a variety of chemical-resistant materials. Generally, the best choices of materials are plastics, such as polyvinyl chloride (PVC); rubber, such as butyl, nitrile, neoprene, or vitron rubber; or non-woven fabrics coated with plastic or another barrier material such as Tyvek®. Barrier laminate materials such as 4H® or Silver Shield® are resistant to most pesticides, but many pesticide handlers consider them uncomfortable to wear and difficult to use while performing many tasks.

The ability of a given material to protect an individual from a pesticide product is largely a function of the type of solvent used to formulate the pesticide product. Watch for signs that the material is not chemically resistant to the pesticide product that you are using. Sometimes it is easy to see when plastic or rubber is not resistant to a pesticide. The material may change color, become soft or spongy, swell or bubble up, dissolve or become like jelly, crack or get holes, or become stiff or brittle. If any of the changes occur, discard the item and choose another type of resistant material.

Always read the pesticide labeling to see if it states which materials are resistant to the pesticide product. In some instances, a pesticide label's PPE

description lists a code letter (A-H) developed by EPA to help the user select suitable PPE. The EPA Chemical Resistance Category Selection Chart is given in Table 6.1.

The chart's code letters are based on the solvents used in a pesticide product, NOT the pesticide's active ingredient. By referring to this chart, a pesticide handler can determine how long a given material can be expected to withstand chemical exposure by a given solvent.

Table 6.1 EPA Chemical Resistance Category Selection Chart

Selection category on label	Type of Resistant Material							
	Barrier laminate	Butyl rubber ≥14 mils	Nitrile rubber ≥14 mils	Neoprene rubber* ≥14 mils	Natural rubber ≥14 mils	Poly-ethylene	Polyvinyl chloride (PVC) ≥14 mils	Vitron ≥14 mils
A Dry & water-based formulations	high	high	high	high	high	high	high	high
B	high	high	slight	slight	none	slight	slight	slight
C	high	high	high	high	moderate	moderate	high	high
D	high	high	moderate	moderate	none	none	none	slight
E	high	slight	high	high	slight	none	moderate	high
F	high	high	high	moderate	slight	none	slight	high
G	high	slight	slight	slight	none	none	none	high
H	high	slight	slight	slight	none	none	none	high

* Includes natural rubber blends and laminates.

High: Highly chemically resistant. Clean or replace PPE at end of each day's work period. Rinse off pesticide at breaks.

Moderate: Moderately chemically resistant. Clean or replace PPE within an hour or two of contact.

Slight: Slightly chemically resistant. Clean or replace PPE within 10 minutes of contact.

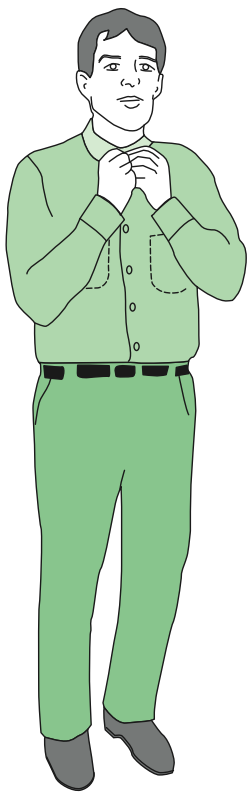
None: Not chemically resistant. Do not wear this type of material as PPE when contact is possible.

For example, if a certain pesticide label states that the user should choose gloves based on the guidelines in Category E, then select only gloves made from barrier laminate, nitrile rubber, neoprene rubber, or vitron. These materials would be expected to give protection for one or more days. Polyethylene gloves and natural and butyl rubber gloves would be expected to provide protection for only 10 minutes or less.

Different materials that are resistant to a particular pesticide do not necessarily provide protection for the same amount of time. Some materials restrict pesticide entry for a fairly long time, while others allow the pesticide to penetrate the PPE fairly quickly. Thin materials, such as disposable plastic gloves, shoe covers, or aprons, may provide the necessary protection for short-term tasks (taking a few minutes), but longer jobs usually require heavier material. Chemical resistance is often stated in exposure time. For example, neoprene is resistant to acetone for 30 minutes or less, and resistant to diesel fuel for more than 4 hours. If you wear neoprene gloves while handling pesticides containing an acetone solvent, change the gloves at least every 30 minutes or the pesticide product (acetone plus active ingredients) might penetrate the gloves and get onto your hands. Check the PPE manufacturer's brochure for information on the allowable length of exposure to specific chemicals.

Another factor to consider is the exposure situation. Chemical-resistant materials do not protect you when they become damaged during the pesticide-handling task. For tasks that involve handling sharp or pointed objects or walking through rough terrain, select a heavy-duty or sturdy material to ensure chemical resistance.

PROTECT YOUR SKIN



At a minimum wear a long-sleeved shirt, long pants, and socks when working around pesticides.

Your skin usually gets the most exposure while handling pesticides. Pay particular attention to covering as much of your skin as possible. Remember that PPE protects you only if the pesticide remains on the outside of the protective clothing. If the pesticide gets inside next to your skin, the protective clothing works against you. It then holds the pesticide tightly against your skin as long as you wear the PPE. This increases the likelihood for contact injury or skin absorption and systemic injury.

Work Clothes

Ordinary shirts, pants, shoes, and other work clothes are usually not considered PPE, even though pesticide labels often indicate that specific items of work clothing should be worn during certain activities. Anytime you handle pesticides or work around pesticide residues, wear, at a minimum, a long-sleeved shirt, long pants, and socks. Make sure the long-sleeved shirt and long pants are made of sturdy material and are free of holes and tears. Fasten the shirt collar completely to protect the lower part of your neck. The tighter the fabric weave, the better the protection. In some instances, the product label requires that you also wear a coverall, a chemical-resistant suit, or a chemical-resistant apron over your work clothes.

Coveralls

The protection offered by chemical-resistant clothing depends on the fabric and design features such as flaps over zippers, elastic at the wrists and ankles, and seams that are bound and sealed. Make sure coveralls are made of sturdy material such as cotton, polyester, a cotton-synthetic blend, denim, or a non-woven fabric such as Tyvek®. When wearing a coverall, close the opening securely so the entire body (except the feet, hands, neck, and head) is covered. When wearing a two-piece outfit, do not tuck the shirt or coat in at the waist—have the shirt extend well below the waist of the pants and fit loosely around the hips. Wear a coverall over a long-sleeved shirt, long

pants, and socks when handling pesticides that exhibit moderate or high dermal toxicity or are skin irritants.

Several factors determine how well a coverall protects you. First, the coverall needs to fit loosely. Each layer of clothing and each layer of air between the pesticide and your skin provide added protection. That is why the coverall needs to fit loosely. If the coverall fits too tightly, there is not a layer of air between it and your skin, and any pesticide that gets through the coverall comes in direct contact with your skin.

The design and structure of the coveralls also affects how well they protect you. Well designed coveralls have tightly constructed, sealed seams and snug, overlapping closures that do not allow gaps and do not unfasten readily. For example, many coveralls have zippers that are covered by flaps for added protection. This type of construction makes it harder for pesticides to get through these areas and come into contact with your inner clothing or skin. Some coveralls, such as those made of Tyvek®, are water resistant and disposable.

Chemical-resistant Suit

Some product labels require the handler to wear a chemical-resistant suit. This usually indicates the pesticide is very hazardous because of either acute or delayed effects. In these instances, take extra care to prevent the pesticide from getting on you.

If you expect that a large amount of pesticide could be deposited on your clothing over an extended period of time, wear a chemical-resistant suit even if the product label does not require it. Under these circumstances, even pesticides that are applied dry, such as dusts or granules, can get through ordinary fabric and may harm you.

Chemical-resistant suits made of rubber or plastic are sold as one-piece coveralls or as two-piece outfits consisting of a jacket worn over overalls. Chemical-resistant suits made of coated non-woven fabric usually are sold as one-piece coveralls.

The biggest drawback to chemical-resistant suits is they may make you uncomfortably warm. Unless you are handling pesticides in cool or climate-controlled environments, heat stress becomes a major concern. Take extra care to avoid heat stress by drinking plenty of water and taking frequent rest breaks to cool down.

Jack Kelly Clark, University of California Statewide IPM Program

A well-designed coverall makes it hard for pesticides to get through to your inner clothing or skin.

Chemical-resistant Apron

An apron protects you from splashes, spills, and billowing dust, and it protects your coveralls or other clothing. Consider wearing an apron whenever you handle pesticide concentrates. The product label may require that you wear a chemical-resistant apron when mixing or loading a pesticide or cleaning application equipment.

Choose an apron that extends from your neck to at least your knees. Some aprons have attached sleeves and gloves. This style of apron protects your arms and hands and the front of your body by eliminating the potential gap where the sleeve and glove or sleeve and apron meet.

However, an apron can pose a safety hazard when you are working around equipment with moving parts. If an apron can get caught in machinery or get in your way, wear a chemical-resistant suit instead.

Jack Kelly Clark, University of California Statewide IPM Program

Choose a chemical-resistant apron that extends from your neck to at least your knees.

Gloves and Footwear

Pesticide handlers get, by far, the most exposure from pesticides on their hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to the hands and 13 percent to the forearms. The same study showed that wearing chemical-resistant gloves reduced exposure by 99 percent. As a result, most product labels require use of waterproof or chemical-resistant gloves during

handling and mixing activities. Do not wear lined gloves because the lining can absorb pesticides. Wear gloves anytime you might get pesticides on your hands, such as when working around contaminated equipment or other contaminated surfaces.

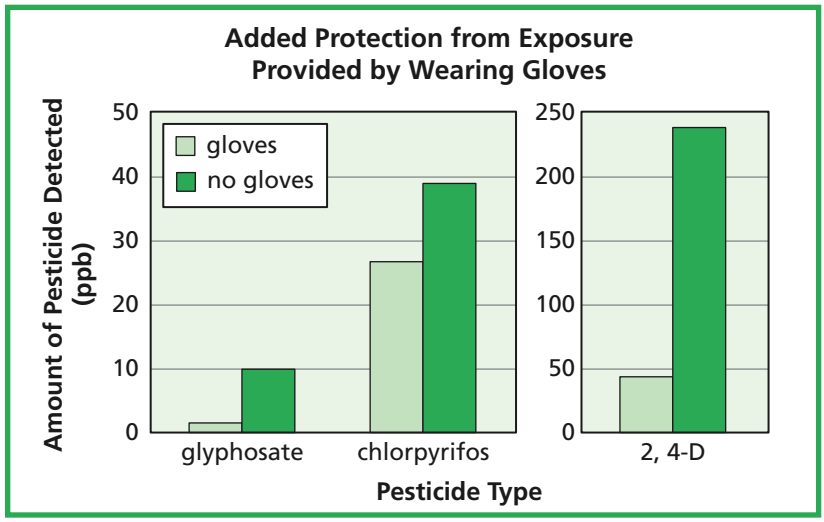


Figure 6.1
*Farmers who wore gloves while applying pesticides reduced their risk of exposure (*The Farm Family Exposure Study, *John Acquavella).*

Pesticide handlers often get pesticides on their feet. Sturdy shoes and socks are sufficient to protect your feet during many handling activities. Canvas and leather shoes are inappropriate when using pesticides because these materials absorb pesticides easily and cannot be decontaminated. Use waterproof or chemical-resistant footwear when handling pesticide concentrates or making applications, or when residues pose a high hazard to your feet. Some product labels require that you wear waterproof or chemical-resistant footwear, which could mean shoe covers or boots. If a pesticide is likely to get on your lower legs or feet, wear chemical-resistant boots that extend past your ankle and at least halfway up to your knee. Wearing waterproof boots is especially important if you enter or walk through treated areas before the spray has dried, such as pesticide applications made to lawns.

Edward Crow, Maryland Department of Agriculture

Nitrile and rubber gloves.

Some formulations may require specific types of gloves and footwear. Do not wear gloves or footwear when handling certain fumigants, such as methyl bromide. The gloves and footwear can trap the fumigant gas near the skin and cause burns. Other fumigants, such as aluminum and magnesium phosphide, specify gloves made of cotton or a similar material be worn when handling the product. Like other pesticides, fumigant labels specify the appropriate PPE required to protect the applicator from exposure.

Wear gloves and footwear correctly. Make sure that you choose gloves and footwear appropriate for the pesticide being handled. Always start out with new or freshly cleaned gloves and footwear that are in good condition. Do not grab a pair just because they are handy—they may not have been properly cleaned and may still have pesticides on or in them. If pesticide gets inside your gloves or footwear, take them off immediately, wash your hands or feet, and put on clean protective equipment. Keep several pairs of gloves and footwear available and change to a clean set whenever they become damaged or you suspect the inside has become contaminated.

Avoid contaminating the inside of gloves and footwear. Contamination often occurs when applicators remove their gloves during an application to adjust the equipment or their PPE, open a pesticide container, or wipe their faces, and then replace the gloves over their contaminated hands. If you must remove your gloves during a handling activity, wash your gloves thoroughly before taking them off, wash your hands thoroughly and dry them before you touch anything, and put the gloves on again when you return to work. Another common mistake is putting on footwear with contaminated hands, thereby transferring pesticides from your hands to your feet and socks.

Be careful not to allow pesticides to run down your sleeves into your gloves. For jobs in which your arms are mostly lowered, place sleeves outside the gloves. Use gloves that go up over your wrist and at least halfway to your elbow. For jobs in which your arms are mostly raised, leave your gloves outside your sleeves. Fold the cuff of

your gloves up 1 or 2 inches toward your fingers to catch the pesticide before it runs down your arm. For many jobs, you will be working some of the time with your arms raised and some of the time with them lowered. In these cases, close the glove cuff tightly outside the sleeve and put heavy-duty tape or an elastic band around the end of the glove where it meets the sleeve (see Figure 6.2). Some gloves have a method of tightening the cuff to your sleeve so the pesticide cannot run down into the glove.

Take care so pesticides do not run down your pant legs and into your footwear. Put your pant legs outside your boots to prevent this from occurring.

Hats

For overhead exposure or exposure to a lot of airborne particles, wear something to protect your head and neck, such as a wide-brimmed hat or chemical-resistant hood. Plastic safari hats with plastic sweatbands are a good choice because they are relatively cool in hot weather. More flexible hats and hoods are also available in chemical-resistant materials. Hats must not contain absorbent material such as cotton, leather, or straw. Many chemical-resistant jackets or coveralls can be purchased with attached protective hoods.

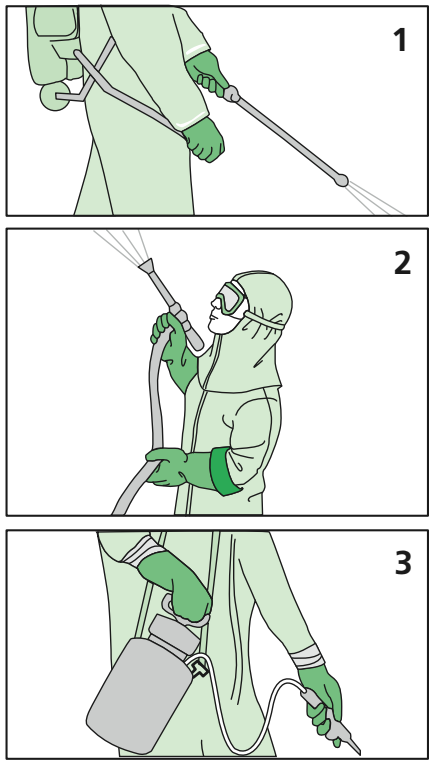


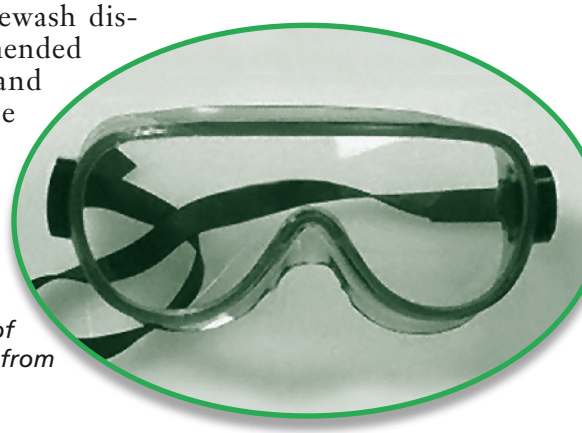
Figure 6.2
Wear gloves according to how you are applying the pesticide: (1) sleeves over gloves for jobs where your hands are mostly lowered, (2) gloves outside your sleeves with cuff folded up 1 or 2 inches when spraying above your head, and (3) cuffed tightly outside the sleeve with heavy-duty tape or an elastic band when working with your arms both raised and lowered.

PROTECT YOUR EYES

Eyes are very sensitive to the chemicals contained in some pesticide formulations, especially concentrates. Eyes readily absorb pesticides. Some product labels require a handler to wear protective eyewear. Goggles, a faceshield, or safety glasses with shields at both the brow and sides are examples of protective eyewear. Some labels specify that a particular type of eye protection must be worn. People who wear contact lenses should consult an eye doctor or their physician before using pesticides.

Shielded safety glasses and full faceshields are good choices in many handling situations because they are comfortable, do not cause fogging or sweating, and give good eye protection. Faceshields that are cupped inward toward your throat give better protection from splashes than straight faceshields. Wear goggles that fit tightly against your face if you will be in an open cab during an air-blast application; flagging directly under an aerial application; applying mists, fogs, or aerosols indoors; or in any other situation in which you will be enveloped in a spray, mist, or dust. Select goggles made of polycarbonate that have protected air baffles to avoid fogging. Either goggles or shielded safety glasses can be worn with a half-face respirator. Full-face respirators are supplied with their own faceshields, so additional eye protection is not required.

Under the agricultural Worker Protection Standard, if the label requires goggles for eye protection, then the handler must have immediate access to an eyewash dispenser at all times. Eyewashes can be portable or set in a fixed location such as an eyewash station in a greenhouse. Any user handling pesticide products that require goggles should have an eyewash readily available. If a pesticide gets past the goggle's protection, you do not have time to look for clean water to flush your eyes. Carrying an eyewash dispenser with you is recommended because some corrosive and irritant products can cause injury within a few seconds.



Chemically resistant splash-proof goggles help protect your eyes from pesticide exposure.

Virginia Tech Pesticide Programs

PROTECT YOUR RESPIRATORY TRACT

The respiratory tract consists of the lungs and other parts of the breathing system. It is much more absorbent than the skin. Even if a pesticide label does not require it, consider wearing a respirator if you are handling any product for which the label states "do not breathe vapors or spray mist" or "harmful or fatal if inhaled." In addition, wear a respirator if you will be exposed to any pesticide that can potentially be inhaled.

Types of Respirators

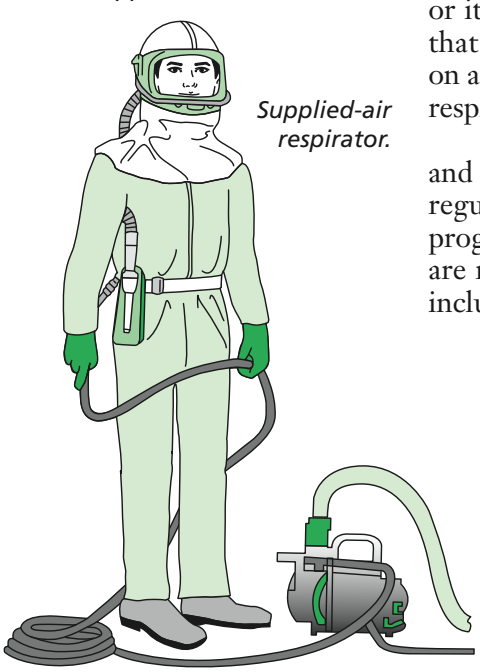
Air-supplying respirators

- Supplied-air respirator
- Self-contained breathing apparatus (SCBA)

Air-purifying respirators

- Non-powered particulate respirators (filtering facepiece, dust/mist mask)
- Powered particulate respirators
- Chemical cartridge respirators (half facemask and full facemask)
- Gas masks with canisters

Self-contained breathing apparatus (SCBA).



Supplied-air respirator.

Some fumigants and a few other pesticide formulations contain a chemical warning additive in the product formulation that alerts you when you begin to inhale the pesticide. Such warning agents are often used when the pesticide active ingredient is highly toxic but is not easily detected by smell. The additive may have a characteristic odor or it may be a mild irritant to alert you that you need leave the area or to put on a respirator, or to warn you that your respirator is no longer protecting you.

The federal Occupational Safety and Health Administration (OSHA) has regulations for a respiratory protection program. The following eight elements are required for all users of respirators, including pesticide handlers:

1. Procedures to select the proper respirator for your worksite or job.
2. Medical evaluation to determine ability to use a respirator.
3. Fit testing for tight-fitting respirators.
4. Proper use of respirators.
5. Care and maintenance of respirators.
6. Breathing air quality and use for supplied-air respirators.
7. Training on hazard recognition, dangers, and proper use and care of respirators.
8. Program evaluation on respirator fit, selection, use, and maintenance.

Most states have adopted the OSHA respirator standard into state law.

Respirators

Respirators protect you from breathing pesticide-contaminated air. Various pesticide formulations require different types of respirators. The product label states whether you must use a respirator and, if so, which type.

A respirator is a safety device that covers at least the mouth and nose. Two major groups of respirators are used when dealing with pesticides—air-supplying and air-purifying respirators. **Air-supplying** respirators provide clean, uncontaminated air from an outside source. They are used in low-oxygen environments and are generally more expensive. Often their big and bulky size puts a strain on the worker. **Air-purifying** respirators use physical and chemical filters to trap and remove contaminants as they pass through the respirator with the air being breathed by the wearer. The pesticide label provides guidance on which type of filters or cartridges to use. Adequate oxygen must be present in the air that is being breathed because an air-purifying respirator does not supply oxygen; it only filters the air that is being breathed.

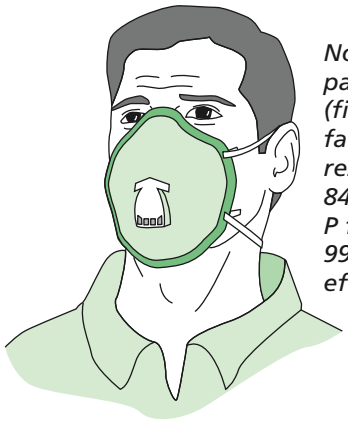
Air-purifying devices may be powered or non-powered. The powered air-purifying respirators use a blower to move the contaminated air through a purifying filter and can be used with either a tight-fitting facepiece or a loose-fitting hood. The non-powered devices can be either half-mask or full-face devices that place a filtration unit

between your breathing passage and the contaminated air source. Filters and cartridges are chemical specific or dust/mist specific. A combination chemical and dust/mist cartridge is also available. When handling some pesticides, an organic (OV) cartridge is required. The components of a typical non-powered air-purifying respirator are a snap-on retainer, a prefilter, an air-purifying cartridge, a facepiece that contains an exhalation valve, and a harness.

The National Institute for Occupational Safety and Health (NIOSH) is the federal agency responsible for testing and certifying respirators used in conjunction with pesticides (and other non-mining respiratory protection). Approval numbers beginning with the letters TC are assigned to all respirators reviewed by the agency and must be on the box containing the facepiece. Pesticide product labels often specify the type of respirator required by listing its TC number. In addition, filters are classified on the basis of oil degradation resistance and filter efficiency. The classification levels for oil degradation resistance are N—not oil resistant; R—oil resistant; and P—oil proof. The filter efficiency for each classification level may be 95, 99, or 100 percent. The following is a list showing several types of respirators and their TC code designations under the NIOSH classification system:

- TC–84A—non-powered particulate respirators (N, P, and R filters).
- TC–21C—powered particulate respirators only (100 series filters).
- TC–23C—chemical cartridge respirators.
- TC–14G—gas masks with canisters.
- TC–19C—supplied-air respirators.
- TC–13F—self-contained breathing apparatus.

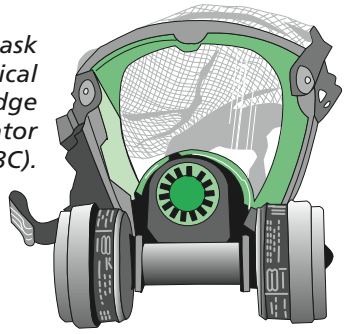
The product formulation, toxicity, and type of application influence the type of respirator needed. Manufacturers use criteria approved by the EPA to assign



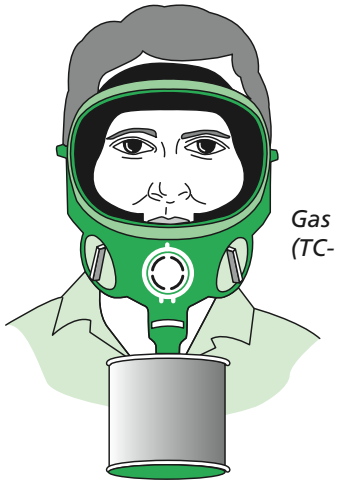
Non-powered particulate (filtering facepiece) respirator (TC-84A; N, R, or P filters; 95, 99, or 100% efficiency).

Powered particulate respirator (TC-21C).

Half facemask chemical cartridge respirator (TC-23C).



Full facemask chemical cartridge respirator (TC-23C).



Gas mask with canister (TC-14G).

Adapted from University of Illinois Private Applicator manual

Components of a typical non-powered air-purifying respirator include a snap-on retainer, a prefilter, an air-purifying cartridge, and a facepiece with exhalation valve and harness.

Edward Crow, Maryland Department of Agriculture

Table 6.2 Label Examples Based on the EPA Respiratory Protection Criteria

EPA Criteria	Label Statement for Respiratory Protection
Solid pesticides with Toxicity Class II, III, or IV	Use a NIOSH-approved respirator with any N, R, P, or 100 series prefilter.
Liquid pesticides, Toxicity Class I	Use a NIOSH-approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P, or 100 series prefilter.
Gas applied in enclosed area	Use an air-supplying respirator with NIOSH TC–19C, or use a self-contained breathing apparatus with NIOSH TC–13F.

PPE respirator requirements on labels (see Table 6.2). When a pesticide label requires a respirator, wear a NIOSH-approved respirator for use with that particular pesticide. Remember, a single type of respirator does not adequately protect you from every pesticide or formulation that you may use.

Filtering facepiece respirators or non-powered particulate respirators (TC–84A) are dust/mist-filtering respirators. They offer protection from small particles in the air. They cover the nose and mouth to filter out dusts, mists, powders, and particles. They are to be disposed of after each use.

Chemical cartridge respirators (TC–23C) and gas masks with canisters (TC–14G) absorb harmful vapors or gases. In addition, chemical cartridge respirators and gas masks with canisters usually have an external dust/mist filter. Chemical cartridge respirators come in both half-facemask and full-facemask styles. The cartridge must be appropriate for the particular contaminant (organic vapor, phosphine, etc.).

Powered air-purifying respirators (TC–21C) use a fan to help draw air through an air-purifying cartridge and may reduce respiratory stress and heat stress, but they have a high start-up cost. The cartridge must be appropriate for the particular contaminant (organic vapor, phosphine, etc.).

Supplied-air respirators (TC–19C) use long hoses to supply air to a full facemask. Some but not all supplied-air respirators have a blower or compressor.

The self-contained breathing apparatus (TC–13F) uses a compressed-air tank and provides complete respiratory protection against toxic gases in an oxygen-deficient environment.

If the label recommends a NIOSH/MSHA (Mine Safety and Health Administration) respirator, this reference is to an older classification system. In this system TC–21C designated mist/dusk mask respirators. Under the new NIOSH system this designation is now TC–84A. Be sure to use an appropriate respirator for the pesticides you are using.

Use Respirators Properly

According to OSHA's respiratory protection standard (29 CFR 1910.134), employers must provide a medical evaluation to determine an employee's ability to use a respirator before the employee is fit tested or required to use the respirator in the workplace. Employees must also receive training on the proper use of the respirator for which they have been fit tested.

To work properly and provide the necessary protection, a respirator must fit your face tightly. The **fit test** is a method used to select the right size respirator for the user. OSHA's respiratory protection standard requires a fit test prior to initial use of a respirator, whenever a different respirator facepiece is used, and at least annually thereafter. An additional fit test is required whenever there are changes in the user's physical condition that could affect respirator fit (e.g., facial scarring, dental changes, cosmetic

surgery, or an obvious change in body weight). All employees using either a negative or positive pressure tight-fitting facepiece respirator must pass an appropriate fit test.

The fit test used depends on the type of respirator and the relative workplace exposure level. There are both qualitative and quantitative fit tests. In a **qualitative fit test,** a worker is exposed to an atmosphere containing an odorant, irritant, or taste agent and then asked to breathe normally, breathe deeply, move the head from side to side and up and down, grimace, bend at the waist, and talk. The wearer reports any noticeable odor or taste agent that leaks into the mask.

In a **quantitative fit test,** a particle-counting instrument is used to measure respirator fit by comparing the dust concentration in the surrounding air with the dust concentration inside the respirator. The ratio of these concentrations is called the **fit factor.** A modified filter cartridge (or a modified respirator facepiece) equipped with a sample port is used to collect air from inside the respirator. Having the sampler attached, the wearer is asked to make the same movements as described for the qualitative fit test. During these movements, the particle-counting device measures any leakages.

Every time you put a respirator on, conduct a **fit check,** also referred to as a **user seal check,** to be sure the respirator forms a complete seal around your face and air cannot leak in or out along the edges. To perform the fit check, the respirator must be put on properly. Make sure you have obtained a firm and comfortable fit against the face at all points.

There are two types of fit checks—the positive pressure check and the negative pressure check. "Positive pressure" refers to the user breathing out and exerting positive pressure on the respirator, and "negative pressure" refers to the user breathing in and exerting negative pressure on the respirator. The fit check must be performed before using a respirator in the field and may also be performed periodically while in the field.

- **Positive pressure check**—Cover the exhalation valve with your hand and exhale gently into the facepiece. If a slight positive pressure is built up inside the facepiece without any evidence of leakage, the fit is satisfactory. This test method is the most widely used to check proper fit in the field.

In a quantitative fit test, a particle-counting instrument is used to measure respirator fit.

- **Negative pressure check**—Close off the air inlet valves (i.e., cover the cartridges with your hands), inhale gently to collapse the facepiece slightly, and hold your breath for 10 seconds. If the facepiece remains slightly collapsed and no leakage is detected, the respirator fits properly. It may be difficult to get a good seal when trying to cover the inlet valves (cartridges).

Most respirator styles will not protect you if you have a beard or other facial hair because it does not allow the respirator to seal properly against your face. If you have facial hair, use a loose-fitting hood or helmet-style respirator. Loose-fitting respirators include powered particulate respirators that constantly pump air through a cartridge or canister into a loose-fitting helmetlike or hoodlike head covering. The positive outward pressure caused by the steady outflow of air prevents contaminants from entering the headpiece. The purified air circulating over the user's head, face, and neck also provides some cooling. These loose-fitting respirators do not have to form a seal on your face, so they do not need a medical or a fit test, and people with facial hair can use them.

Not all loose-fitting respirators move the air at the same rate. Most pesticide handling tasks require a minimum airflow rate of 4 cubic feet per minute. If you are doing physically strenuous work, use a respirator with

Positive pressure fit check

Negative pressure fit check

Adapted from University of Illinois *Private Applicator* manual

Be sure to perform a fit check each time you use your respirator.

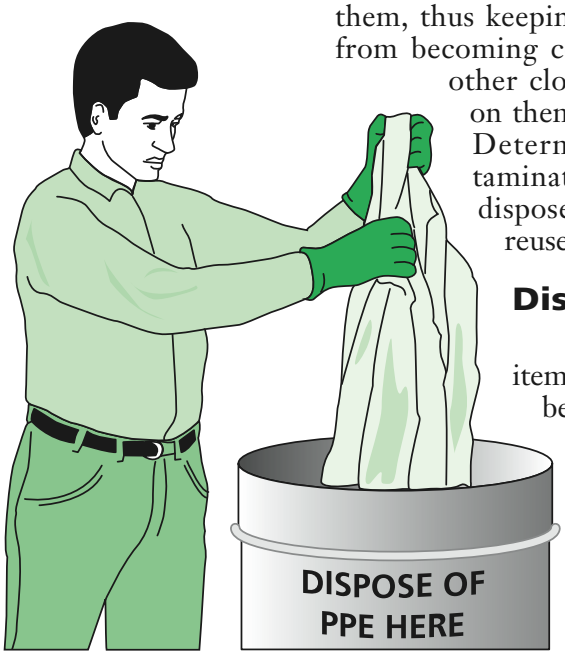
an airflow rate of at least 6 cubic feet per minute. Loose-fitting respirators are not nearly as tiring or as hot as face-sealing respirators.

If you are wearing a respirator that filters out dusts and mists, change the filter or respirator when you find it is getting hard to breathe through the respirator, or if your filter gets torn, damaged, or wet. Do not use a filtering facepiece dust/mist mask if the pesticide soaks the mask. In this case, use a full-face respirator.

If you are wearing a respirator that removes vapors and gases, change the cartridge or canister immediately if you taste or smell pesticide, or if the pesticide burns or stings your nose or throat. Follow the manufacturer's instructions or state regulations on when to replace filters, cartridges, and canisters even if you do not notice a problem. If there are no instructions, replace filters, cartridges, and canisters at the end of each 8-hour work period. To ensure the integrity of the seal between the facemask and the cartridge, make sure the manufacturer of the cartridge is also the manufacturer of the facemask.

MAINTAINING PERSONAL PROTECTIVE EQUIPMENT

When you finish an activity in which you are handling pesticides or are exposed to them, remove your PPE right away. Start by washing the outside of your gloves with detergent and water before removing the rest of your PPE. Wash the outside of other chemical-resistant items before you remove your gloves. This practice helps you avoid contacting the contaminated part of the items while you are removing them, thus keeping the inside surface from becoming contaminated. If any other clothes have pesticides on them, change them also. Determine whether contaminated items should be disposed of or cleaned for reuse.



Discard contaminated PPE in the appropriate container.

Disposables

Disposable PPE items are not designed to be cleaned and reused. Discard them when they become contaminated with pesticides. Place disposable PPE in a separate plastic bag or container prior to disposal.

Chemical-resistant gloves, footwear, and aprons labeled as disposable are designed to be worn only once and then thrown away. These items often are made of thin vinyl, latex, or polyethylene. These inexpensive disposables may be a good choice for brief pesticide handling activities that require dexterity as long as the activity does not tear the thin plastic. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticide into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments.

Non-woven (including coated non-woven) coveralls and hoods, such as Tyvek®, usually are designed to be disposed of after use. Most are intended to be worn for only one workday. The instructions with some coated non-woven suits and hoods permit the user to wear them more than once if each use period is short and not much pesticide gets on them. Pay close attention when reusing these items, and be ready to change them whenever there are signs pesticides could be getting through the material or the inside surface is contaminated.

Dust/mist masks, prefilters, canisters, filtering and vapor-removing cartridges, and a few cartridge respirators are disposables. They cannot be cleaned. Be sure to replace these disposable items often.

Reusables

Some PPE items, such as rubber and plastic suits, gloves, boots, aprons, capes, and headgear, are designed to be cleaned and reused several times.

However, do not make the mistake of continuing to use these items when they no longer offer adequate protection. Wash the reusable items thoroughly between uses, and inspect them for signs of wear or abrasion. Never wash contaminated gloves, boots, respirators, or other PPE in streams, ponds, or other bodies of water. Check for rips and leaks by using the rinse water to form a "balloon" (i.e., filling the PPE item with water) and/or by holding the items up to the light. Even tiny holes or thin places can allow large quantities of pesticide to penetrate the material and reach your skin. Discard any PPE item that shows sign of wear.

Even if you do not see any signs of wear, replace reusable chemical-resistant items regularly—the ability of a chemical-resistant material to resist the pesticide decreases each time an item is worn. A good rule of thumb is to throw out gloves that have been worn for about 5 to 7 workdays. Extra-heavy-duty gloves, such as those made of butyl or nitrile rubber, may last as long as 10 to 14 days. Glove replacement is a high priority because adequate hand protection greatly reduces the pesticide handler's chance for exposure. The cost of frequently replacing your gloves is a wise investment. Footwear, aprons, headgear, and protective suits may last longer than gloves because they generally receive less exposure to the pesticides and less abrasion from rough surfaces. Replace them regularly and at any sign of wear. Most protective eyewear and respirator bodies, facepieces, and helmets are designed to be cleaned and reused. These items can last many years if they are of good quality and are maintained correctly.

Launder fabric coveralls and work clothing after each day's use. Do not attempt to launder clothing made of cotton, polyester, cotton blends, denim, and canvas if these items are drenched or saturated with concentrated pesticides labeled with the signal word DANGER—POISON, DANGER, or WARNING. Always discard any such contaminated clothing or footwear at a household hazardous waste collection site.

Be sure to clean all reusable PPE items between uses, even if they were worn for only a brief period of exposure. Pesticide residues that remain on PPE are likely to penetrate the material. If you wear that PPE again, pesticide may already be on the inside of the material next to your skin. Also, PPE worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic. After cleaning reusable items, place them in a plastic bag or clothing hamper away from your personal clothes and away from the family laundry.

Washing PPE

Always wash pesticide-contaminated items separately from the family laundry. Otherwise, pesticide residues may be transferred to the other laundry and may harm you or your family. Be sure that the people who clean and maintain your PPE and other work clothes know they can be harmed by touching these pesticide-contaminated items. Instruct them to wear gloves and an apron and work in a well-ventilated area, if possible, and avoid inhaling steam from the washer or dryer.

Follow the manufacturer's instructions for cleaning chemical-resistant items. If the manufacturer instructs you to clean the item but gives no detailed instructions, follow the "Procedure for Washing Contaminated PPE" detailed in this chapter. Some chemical-resistant items that are not flat, such as gloves, footwear, and coveralls, must be washed twice—once to clean the outside of the item and a second time after turning the item inside out. Some chemical-resistant items, such as heavy-duty boots and rigid hats or helmets, can be washed by hand using hot water and a heavy-duty liquid detergent.

Jack Kelly Clark, University of California Statewide IPM Program

Always wash pesticide-contaminated items separately from family laundry.

Use the following procedure for washing non-chemical-resistant items such as cotton, cotton/polyester, denim, canvas, and other absorbent materials,

and for most chemical-resistant items.

Hang the washed items to dry, if possible. It is best to let them hang for at least 24 hours in an area with plenty of fresh air. Even after thorough washing, some items still may contain residues. When the items are exposed to clean air and sunlight, most residues move to the surface of the fabric, evaporate, or break down. You may wish to buy two or more sets of PPE so you can leave one set airing while wearing the other set. Do not hang items in enclosed living areas—pesticide residues that remain in the items may evaporate and expose people or animals in the area. If it is not possible to hang fabric items to dry, a clothes dryer may be used. Over time, however, the dryer may become contaminated with pesticide residues.

Procedure for Washing Contaminated PPE

1. Wash only a few items at a time so there is plenty of agitation and water for dilution.
2. Wash in a washing machine, using a heavy-duty liquid detergent and hot water for the wash cycle. Set your washer to the longest wash cycle and two rinse cycles.
3. Use two entire machine cycles to wash items that are moderately to heavily contaminated. (If PPE is too contaminated, bundle it in a plastic bag, label the bag, and take it to a household hazardous waste collection site.)
4. Run the washer through at least one additional entire cycle without clothing, using detergent and hot water, to clean the machine before any other laundry is washed.

Jack Kelly Clark, University of California Statewide IPM Program

Clean goggles, face shields, and respirator bodies and facepieces in detergent and hot water.

Maintaining Eyewear and Respirators

Wash goggles, faceshields, shielded safety glasses, respirator bodies, and facepieces after each day of use. Use a detergent and hot water to wash them thoroughly. Remove any contaminants (such as residual pesticides) under running water with a soft brush. Sanitize them by soaking for at least 2 minutes in a mixture of 2 tablespoons of chlorine bleach in 1 gallon of hot water. Rinse thoroughly to remove the detergent and bleach. After rinsing to remove the detergent and bleach, dry the items thoroughly or hang them in a clean area to dry.

Pay particular attention to headbands. Replace headbands made of absorbent materials with chemical-resistant headbands. After each day of use, inspect all headbands for signs of wear or deterioration, and replace them as needed.

Store respirators and eyewear in an area where they are protected from dust, sunlight, extreme temperatures, excessive moisture, and pesticides or other chemicals. A sturdy plastic bag with a zip closure works well for storage. Store respirator cartridges in an airtight bag or they lose their effectiveness.

Respirator maintenance is especially important. Inspect your respirator before each use. Repair or replace any part that shows signs of wear or deterioration. Maintain an inventory of replacement parts for the respirators you own, and do not use substitutes or incompatible brands. If you keep a respirator for emergency use or as a backup, inspect it at least monthly.

If you remove your respirator between handling activities, follow these guidelines:

- Wipe the respirator body and facepiece with a clean cloth.
- Replace caps, if available, over cartridges, canisters, and prefilters.
- Seal the respirator (*except* for any prefilters) in a sturdy, airtight container, such as a plastic bag with a zip closure. If you do not seal the respirator immediately after each use, the disposable parts will have to be replaced more often because cartridges and canisters continue to collect impurities as long as they are exposed to the air. Prefilters, however, do not lose their effectiveness when exposed to

the air. Remove contaminated prefilters before placing the canisters and cartridges in a zip-closable plastic bag to avoid contaminating the canisters and cartridges.

At the end of every workday that you wear a reusable respirator, be sure to do the following:

- Remove the prefilter. Most filters should be discarded.
- Take off the cartridges or canisters. Discard them or, if they are still usable, replace their caps and seal them in an airtight container, such as a plastic bag with a zip closure.
- Clean and store the respirator as directed above.
- Discard disposable respirators according to manufacturer's instructions. Do not try to clean them.

Remember: Do not store your respirators or other PPE in pesticide storage areas.

Handle respirators with the same care that you give your other protective equipment and clothing. Consult labels and MSDS for instructions about protective equipment and clothing, and remember that protective equipment has limitations. A person is never completely protected and must still use caution and common sense to prevent pesticides from contacting the body.

Edward Crow, Maryland Department of Agriculture

Keep respirators and cartridges stored in a proper storage bag that has a zip closure.

SUMMARY

Proper use and selection of personal protective equipment (PPE) is essential for prevention of pesticide exposures. The PPE items selected for a particular pesticide application depend on the application procedure, the pesticide being applied, and the label requirements. Applicators must be familiar with the various types of PPE available and how well they protect against pesticide exposures.

Choose PPE items to protect the skin, eyes, and lungs from exposure. If there is a risk of pesticides penetrating clothing and contaminating skin, select items made of chemical- resistant materials such as plastics or rubber. Gloves, boots, aprons, suits, and hoods come in chemical-resistant materials such as plastics or rubber. Regular work clothes made of cotton, leather, or canvas are not chemically resistant. Pesticide labels may refer to a chemical resistance category that tells the user how long to expect protection after the pesticide contacts the PPE. Keep a copy of the EPA Chemical Resistance Category Selection Chart on hand for an explanation of how long certain materials provide protection.

In addition to being able to choose the appropriate type of PPE, pesticide users must also know how to wear, clean, and dispose of PPE properly. Wear PPE to prevent pesticides from coming into contact with skin, eyes, or clothing. Clean PPE after each use and wash separately from other clothing to prevent contamination. Dispose of PPE if it has cracks, holes, or rips, or is wearing thin in places. If PPE is contaminated by pesticides that cannot be removed by washing, dispose of it as hazardous waste.

PPE is also available to protect the eyes and lungs. The label often specifies what type of protection to use. Goggles, safety glasses, and faceshields may be worn to protect the eyes. A respirator may be worn to prevent inhalation exposure. The label often lists the type of respirator to use by its "TC" number. Whenever you use an air-purifying, tight-fitting respirator, make sure it has been fit tested specifically for you and understand how to perform the fit check each time you use it. Like other types of PPE, eyewear and respirators must also be worn, cleaned, and stored properly if they are to continue providing protection to the user. Remember, you are legally required to wear all PPE recom-

mended by the label. In many cases, you may want to select additional PPE for added protection. Make sure you are familiar with the level of protection provided by the PPE, and know how to use and wear it properly.